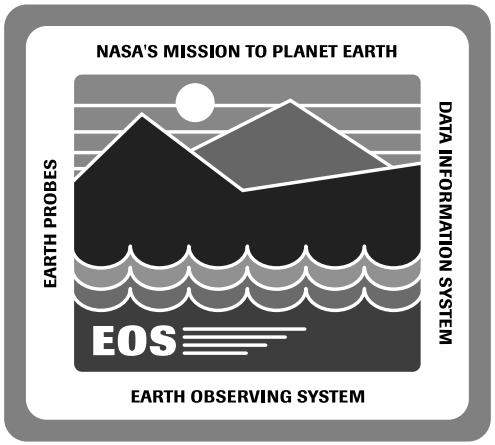


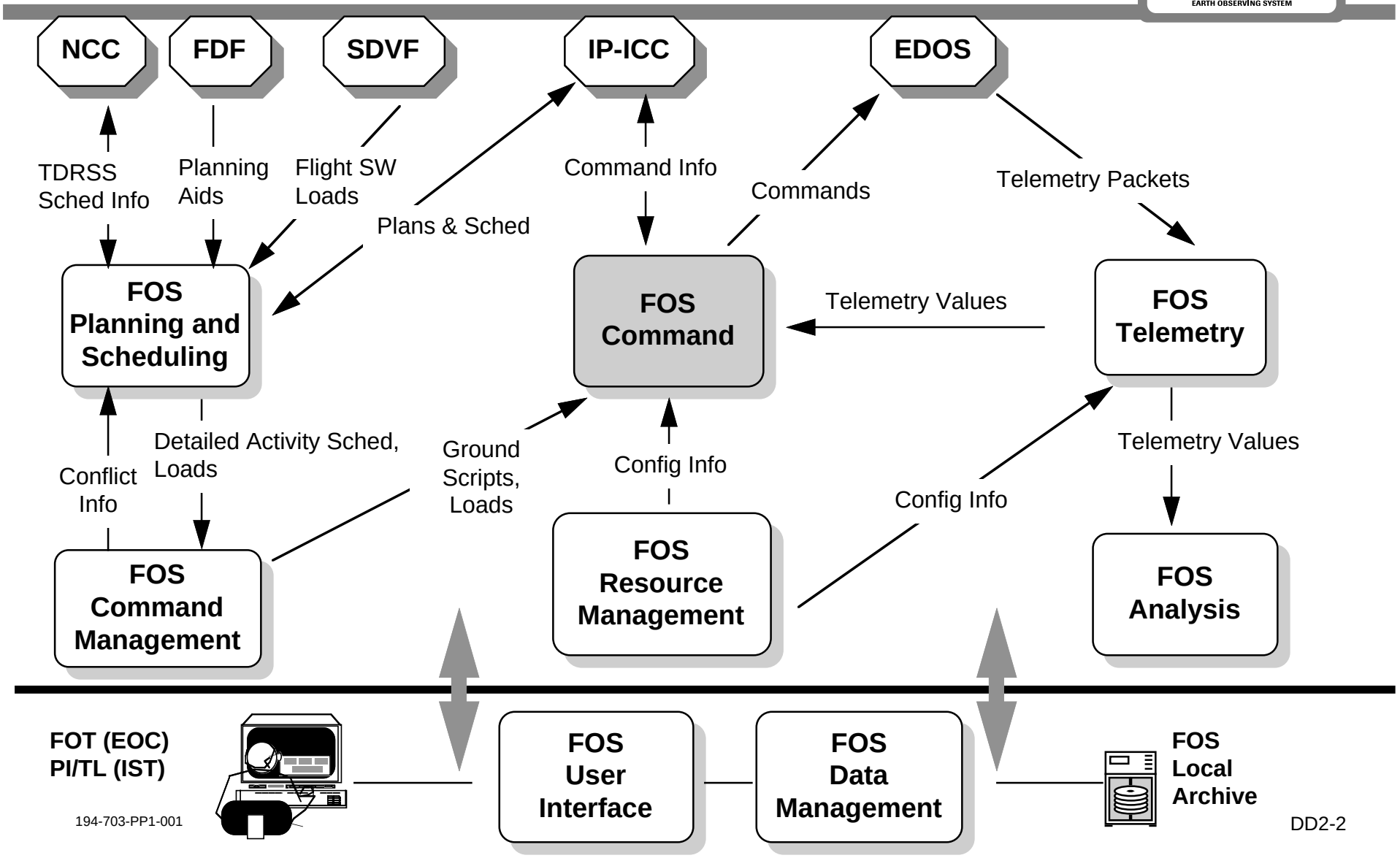
Command Subsystem

Debbie Dunn

System Design Review - 28 June 1994

SDS - 5.4.3

FOS Subsystem Diagram



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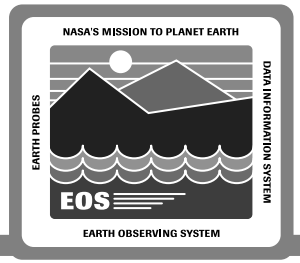
Command Subsystem Outline



Command Subsystem Overview

- Design Drivers

Command Subsystem Context

- Context Diagram
- Interface Description
- Scenarios

Command Subsystem Design

- Object Model
- Design Description
- Scenarios

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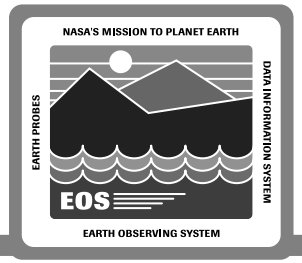
Command Subsystem Overview



Command Subsystem Functions

- Build, validate, uplink and verify real-time commands for the EOS spacecraft and instruments
- Uplink and verify memory loads for the EOS spacecraft and instruments
- Verify execution of stored commands for EOS spacecraft and instruments during a real-time contact

Supports the EOC Operator in performing and monitoring spacecraft and instrument commanding operations

Allows the Instrument Team to monitor spacecraft and instrument commanding operations

Command Subsystem
Design Drivers

Command multiple spacecraft and their instruments simultaneously

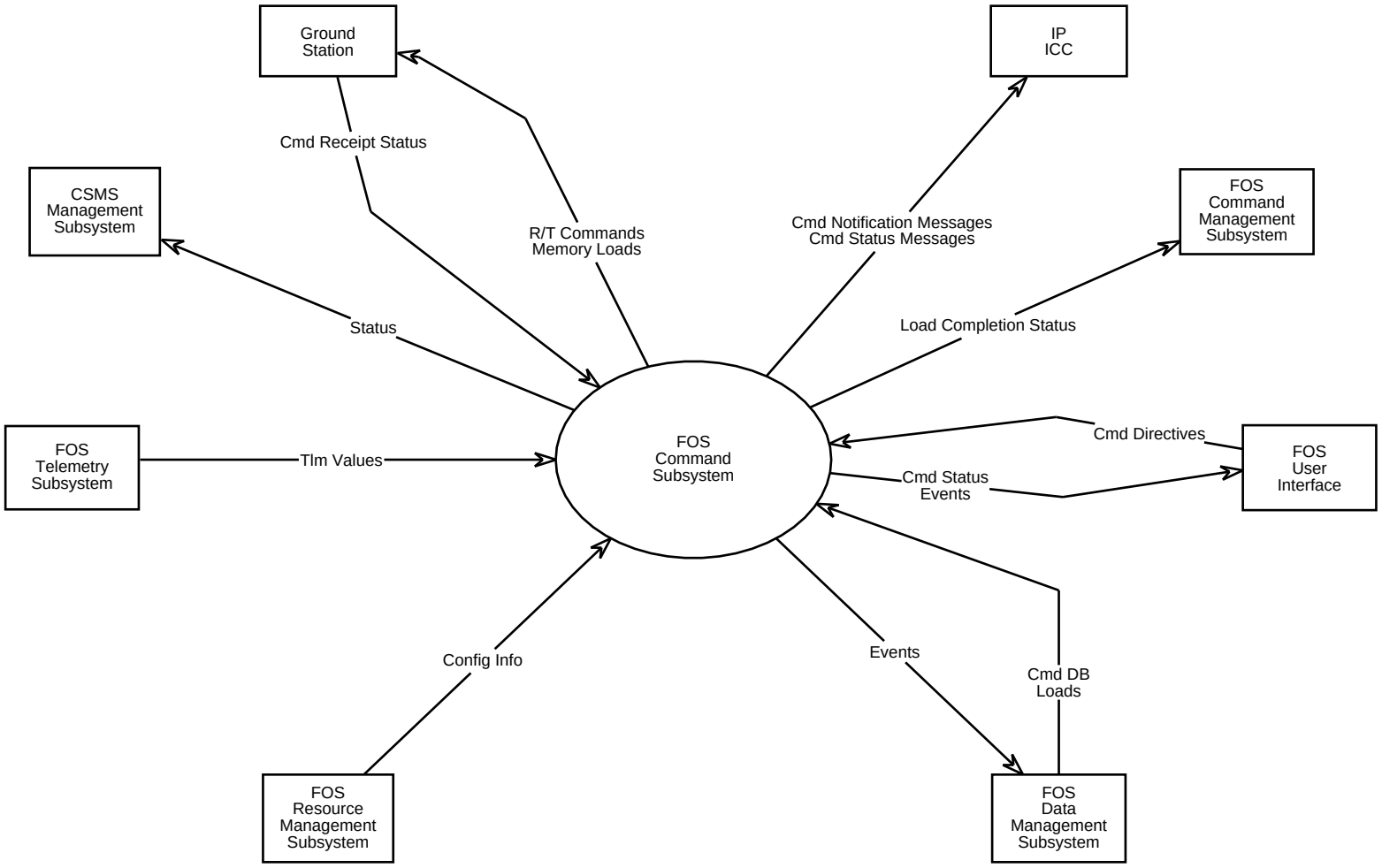
- **Ensure only authorized access to command capability**
- **Guarantee single point of command for a spacecraft and it's instruments**

Support multiple uplink rates

- **Easily reconfigured for different forward link services**

Seamless integration of planned commanding functions

Command Subsystem
Context Diagram



Command Subsystem
Context Description

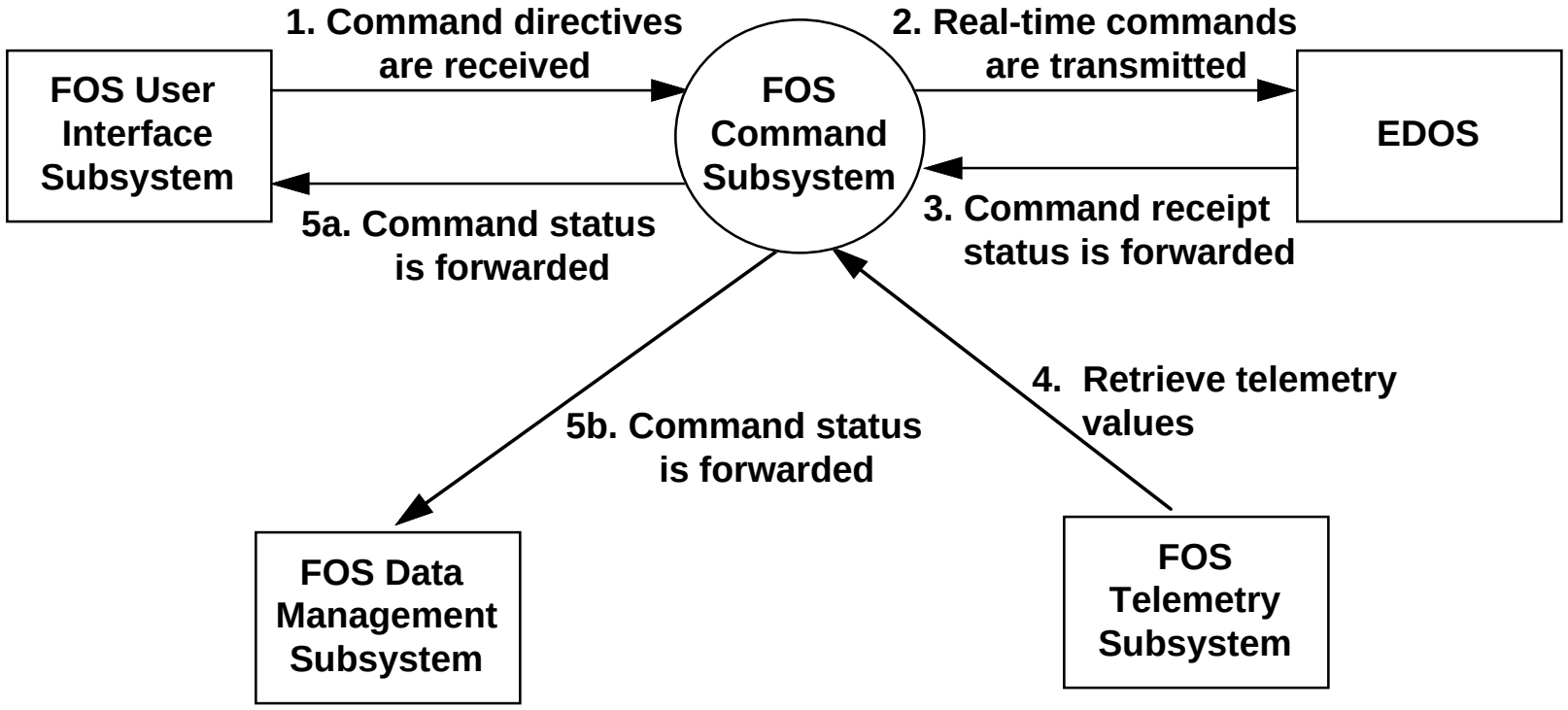
Command Subsystem Interfaces support the following scenarios with respect to real-time operations of the EOS spacecraft and instruments

- **Real-time commanding**
- **Load processing**
- **Stored command verification**

Facilitating Interfaces

- **FOS Resource Management Subsystem provides configuration information (e.g. forward link service information, database identification, command activity controller identification)**
- **FOS Data Management Subsystem provides the Command Database**
- **CSMS Management Subsystem receives command subsystem status**

Command Subsystem
Real-Time Commanding Scenario



Command Subsystem
Real-Time Commanding Scenario

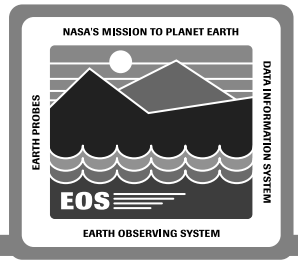
(1) Command directives are received from the FOS User Interface
- Pre-planned real-time command directives from the ground script
- Real-time command directives from a Command Activity Controller
- Real-time command directives from an IP ICC

(Command groups are parsed by the FOS User Interface)

(2) Real-time commands are transmitted to EDOS for uplink via:
- Space Network (SN)
- Deep Space Network (DSN)
- Ground Network (GN)
- Wallops Orbital Tracking Station (WOTS)

(3) Command receipt status is forwarded by EDOS
- Command Link Control Words (CLCWs)

Command Subsystem
Real-Time Commanding Scenario



(4) Telemetry Values are made available by the FOS Telemetry Subsystem

- **Perform real-time command execution verification**

(5a) Command status and events are provided to the FOS User Interface

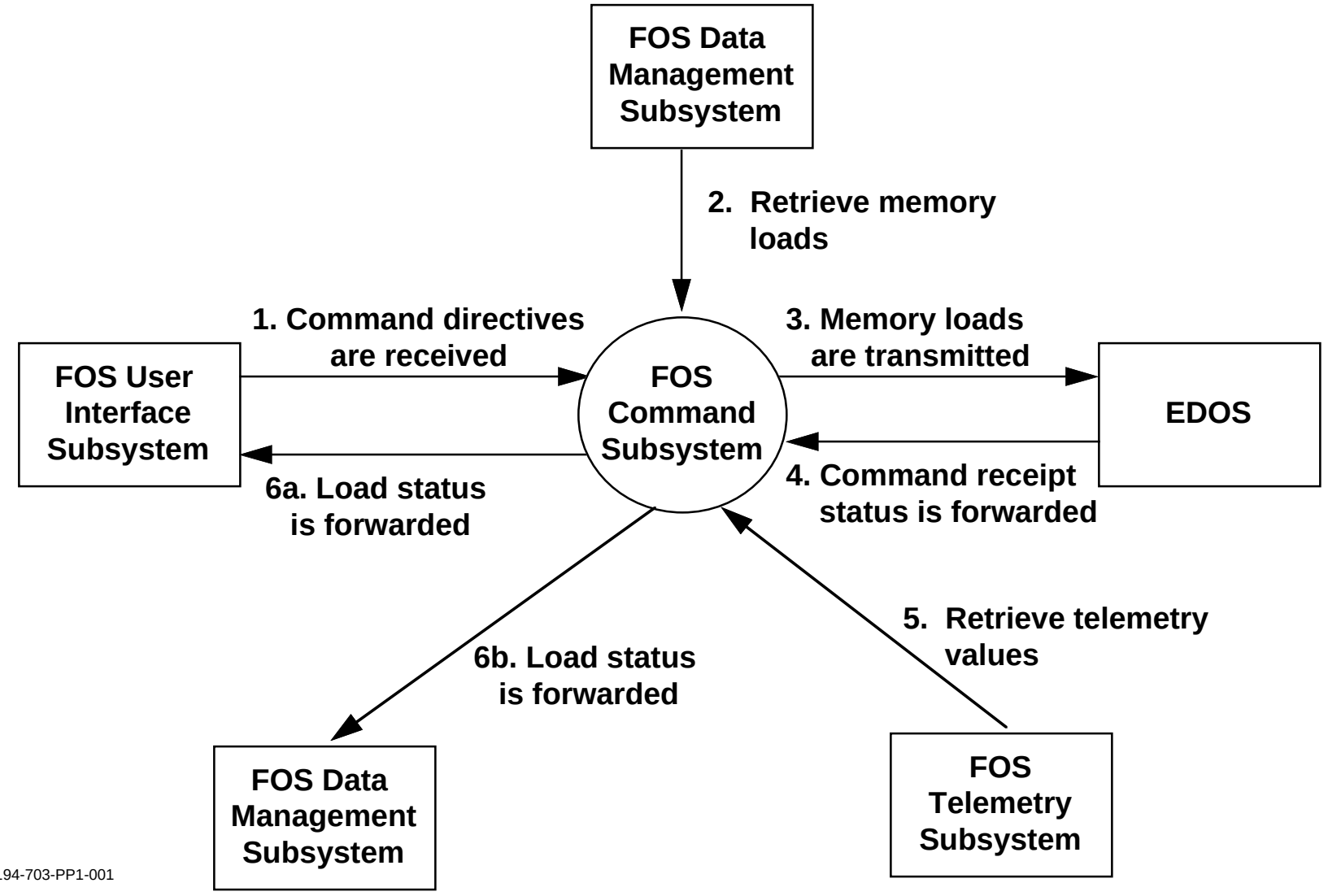
- **Allows the EOC Operators and the Instrument Teams to monitor commanding activity**

(5b) Command status and events are provided to the FOS Data Management Subsystem

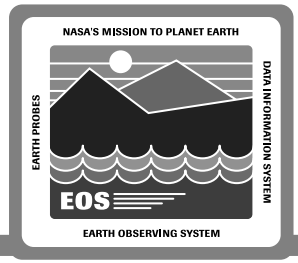
- **For historical logging**

Command status and command notification are provided to IP ICC as required

Command Subsystem Load Processing Scenario



Command Subsystem
Load Processing Scenario



(1) Command directives are received from the FOS User Interface
- **Pre-planned load directive from the ground script**
- **Load directive from the Command Activity Controller**

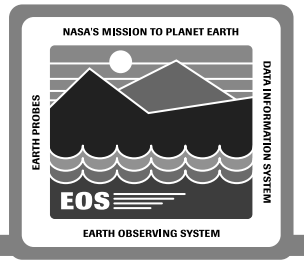
(2) Loads are retrieved from the FOS Data Management Subsystem
- **Load files prepared by the FOS Command Management Subsystem**

(3) Memory loads are transmitted to EDOS for uplink via:
- **SN, DSN, GN, or WOTS**

(4) Command receipt status is forwarded by EDOS
- **Command Link Control Words (CLCWs)**

(5) Telemetry Values are made available by the FOS Telemetry Subsystem
- **Verify load receipt**

Command Subsystem
Load Processing Scenario



(6a) Load status and events are provided to the FOS User Interface

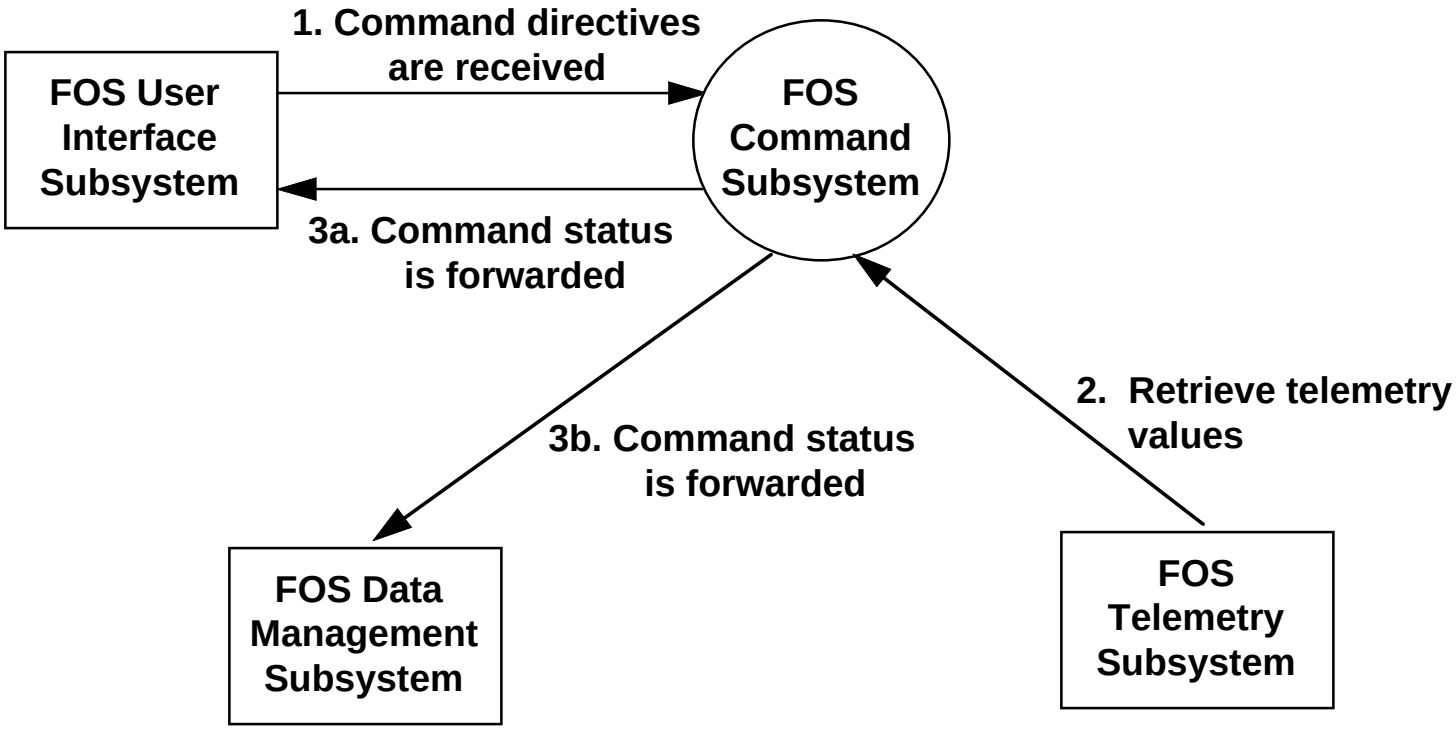
- **Allows the EOC Operators and the Instrument Teams to monitor commanding activity**

(6b) Command status and events are provided to the FOS Data Management Subsystem

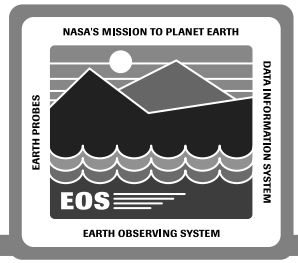
- **For historical logging**

Load completion status is provided to the FOS Command Management Subsystem

Command Subsystem
Stored Command Verification Scenario



Command Subsystem
Stored Cmd Verification Scenario



(1) Command directives are received from the FOS User Interface

- **Stored command verification directives from the ground script**

(2) Telemetry Values are made available by the FOS Telemetry Subsystem

- **Perform stored command execution verification**

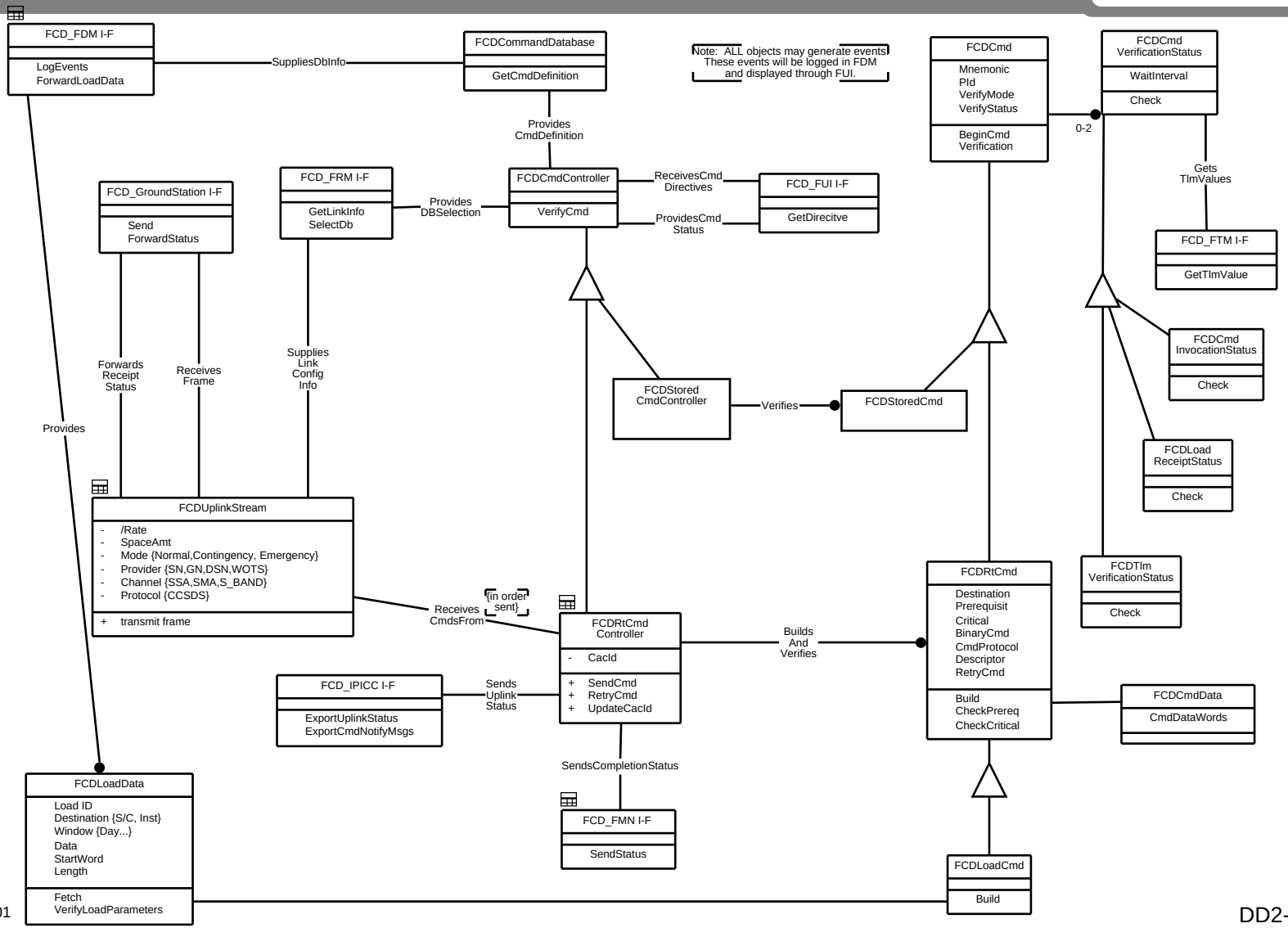
(3a) Command status and events are provided to the FOS User Interface

- **Allows the EOC Operators and the Instrument Teams to monitor onboard command activity**

(3b) Command status and events are provided to the FOS Data Management Subsystem

- **For historical logging**

Command Subsystem
Object Model



Command Subsystem
Design Description

Object Model Scope

- Command Processing of a single EOS spacecraft and it's instruments for a single contact
- Command Processing for multiple spacecraft is realized via multiple instances
- Command Processing for multiple contacts may be handled via new instances or reconfiguration of a given instance

Command Subsystem
Design Description (cont.)

FCDRtCmdController Class

- **Verifies source of real-time command (Command Activity Controller)**
- **Builds, validates and verifies real-time commands**
- **Load commands are a special case of real-time command with associated load data**
- **Forwards commands for uplink based on mode (active, standby)**

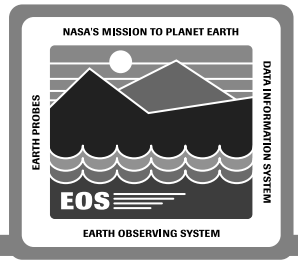
FCDStoredCmdController Class

- **Verifies execution of stored commands**

FCDUplinkStream Class

- **Builds and transmits Command Link Transfer Units (CLTUs)**
- **Meters transmissions according to uplink rate**
- **Performs Command Operations Procedure Processing (COP-1)**
  - **Reviewing AM-1 test-bed implementation**

Command Subsystem Design Description (cont.)



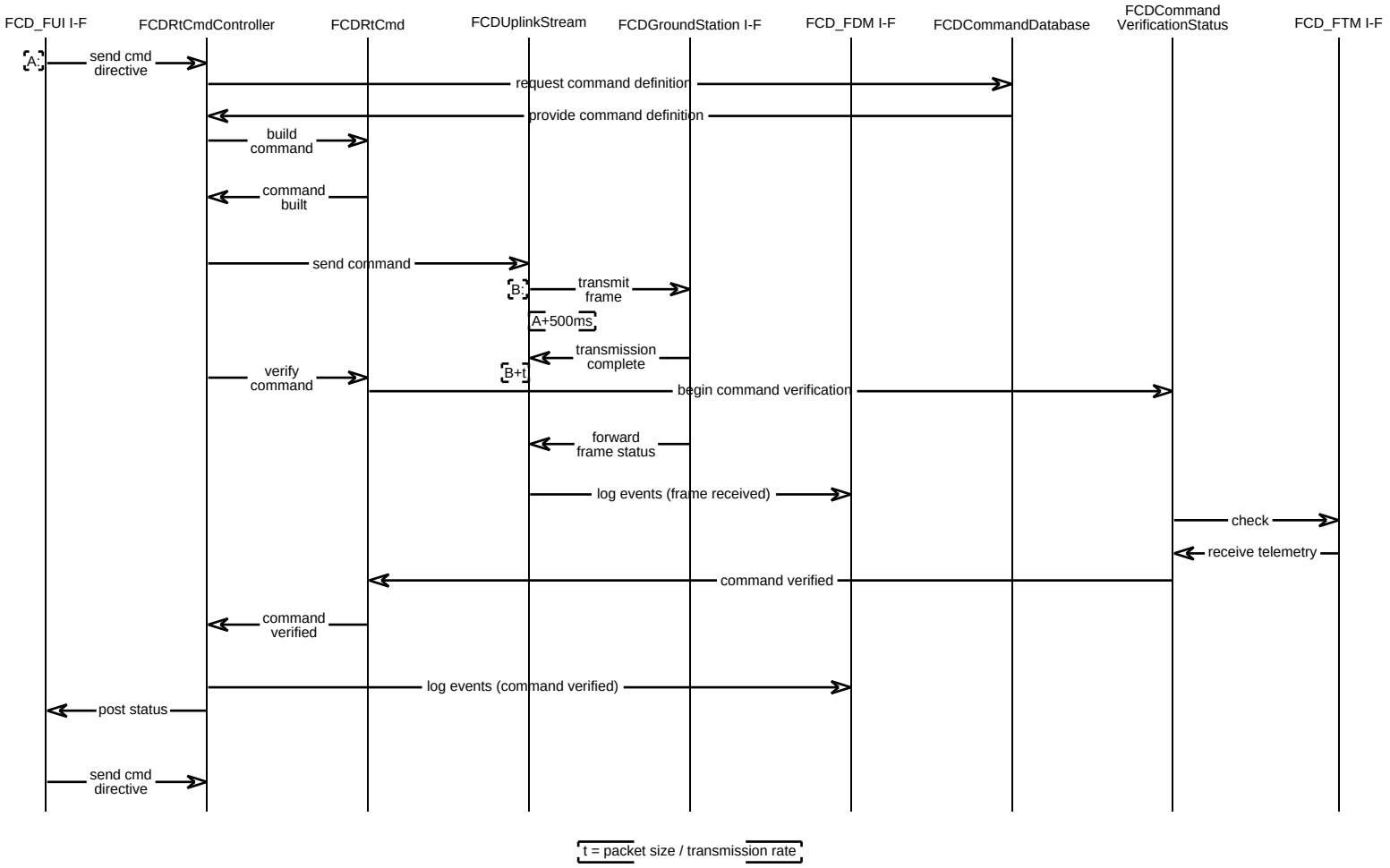
Mission Specific Hooks

- **FCDRtCmd Class**
  - **Build operation is mission specific (e.g. MIL-STD-1553B for AM-1)**
- **FCDCmdVerificationStatus**
  - **Wait interval is mission specific (based on on-board processing and downlink time)**
- **FCDUplinkStream**
  - **Command spacing is mission specific**

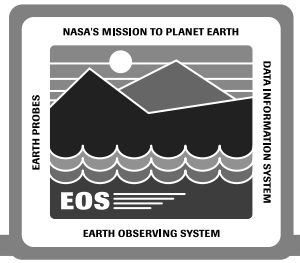
Evolutionary Hooks

- **FCDUplinkStream**
  - **Expandable to handle other protocols (e.g. NASCOM)**
- **FCD_GroundStation I-F**
  - **Expandable to handle other forward link paths**

Command Subsystem
Real-Time Commanding Scenario



Command Subsystem
Real-Time Commanding Scenario



Process command directive received from the FOS User Interface

- **Retrieve command definition from database**
- **Build command**
- **Transmit frame (CLTU) to EDOS**

(Note this processing occurs within 500ms)

Process CLCWs

- **CLCWs are processed asynchronously to command transmission**
- **Verify frame (CLTU) receipt at the spacecraft**
- **Perform retransmission as necessary**
- **Provide command status to FOS User Interface**

Process Command Verification

- **Retrieve telemetry value to perform command execution verification**
- **Provide command status to FOS User Interface**

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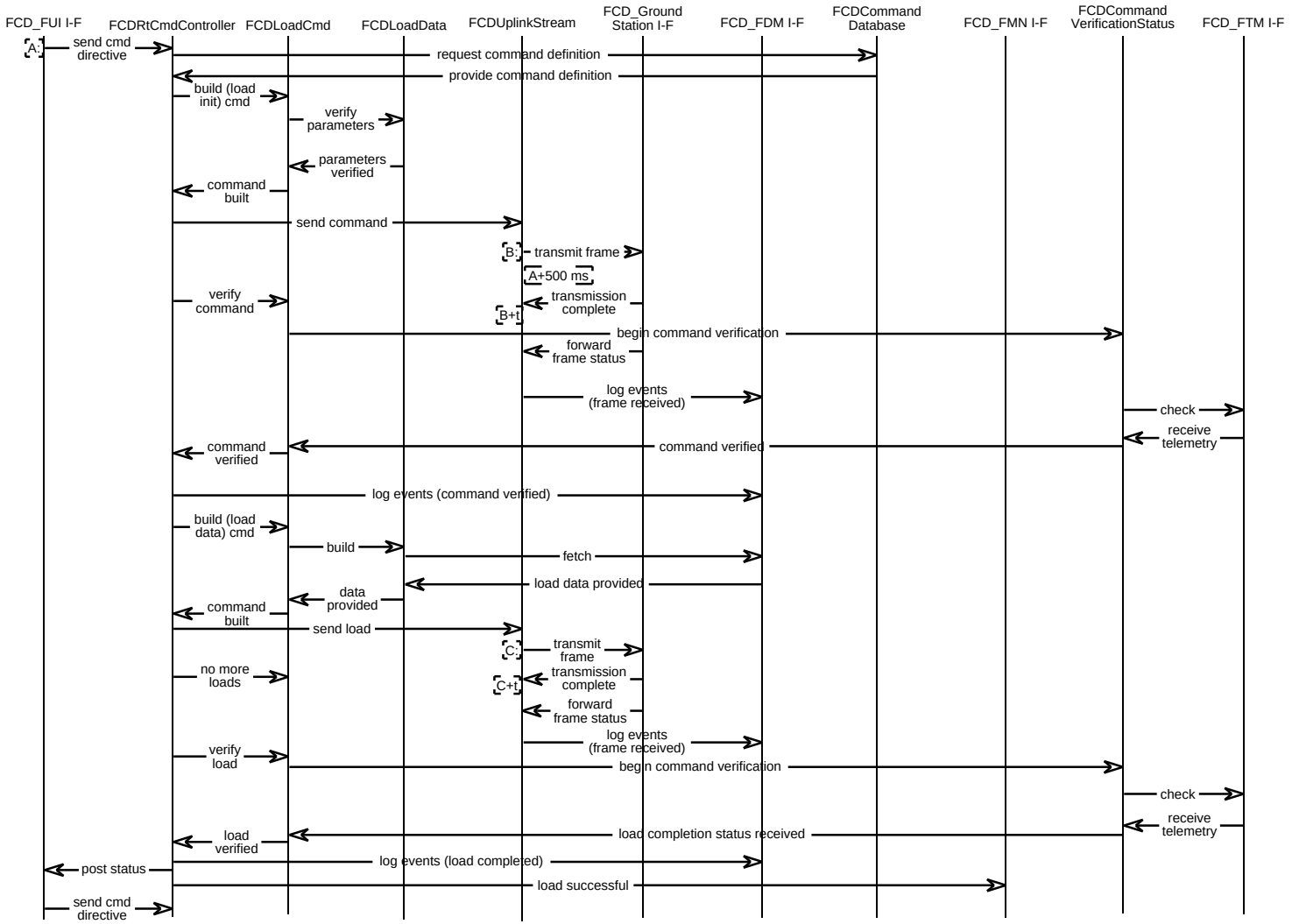
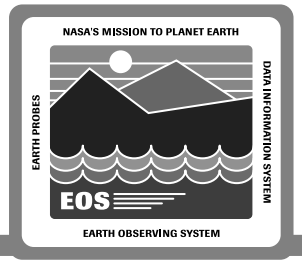
Command Subsystem
Load Processing Scenario



t = packet size / transmission rate

Command Subsystem
Load Processing Scenario



Process command directive received from the FOS User Interface

- **Retrieve command definition from database**
- **Retrieve load file from FOS Data Management Subsystem**
  - **Verify load parameters (e.g. destination, uplink window)**
- **Build commands (load initiate, load data)**
- **Transmit frames (CLTUs) to EDOS**

Process CLCWs

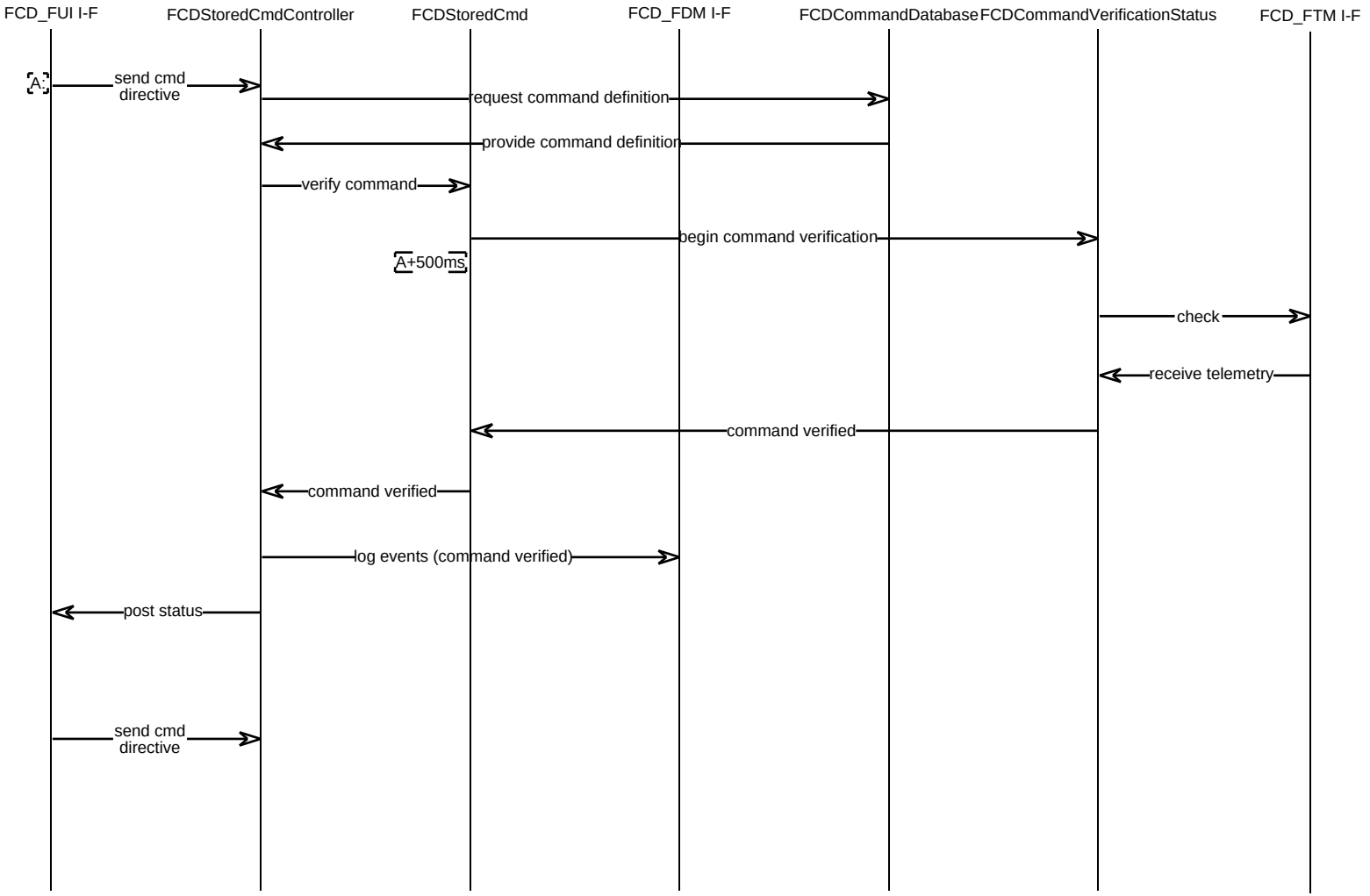
- **CLCWs are processed asynchronously to command transmission**
- **Verify frames (CLTU) receipt at the spacecraft**
- **Perform retransmission as necessary**
- **Provide load status to FOS User Interface**

Command Subsystem
Load Processing Scenario (cont.)

Process Command Verification

- Retrieve telemetry value to perform load receipt verification
  - Cyclic Redundancy Check (CRC) for AM-1
- Provide load status to FOS User Interface
- Load completion status is provided to the FOS Command Management Subsystem

Command Subsystem
Stored Cmd Verification Scenario



Command Subsystem
Stored Cmd Verification Scenario

Process command directive received from the FOS User Interface

- **Retrieve command definition from database**

Process Command Verification

- **Retrieve telemetry value to perform command execution verification**
- **Provide command status to FOS User Interface**